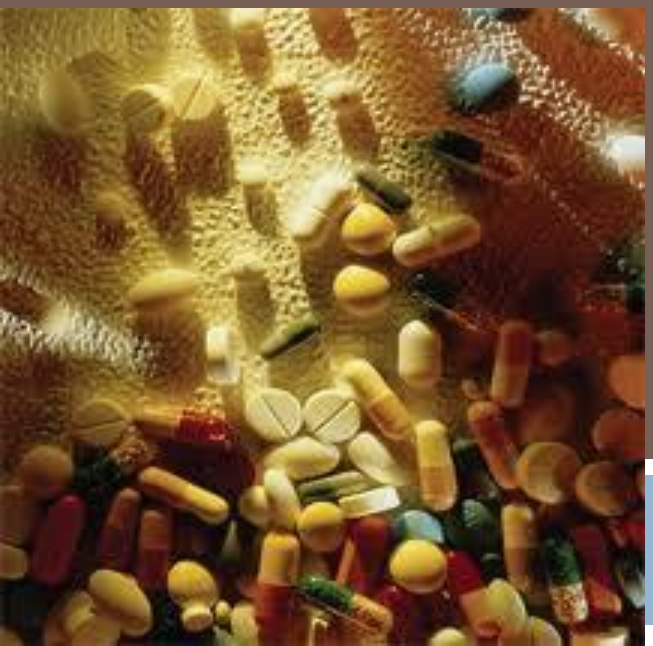
DEVELOPMENT AND EVALUATION OF A PERIOPERATIVE MEDICATION MANAGEMENT DECISION SUPPORT TOOL



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Authors certify that they have no conflict of interest in creating or presenting this work

Learning Objectives

- **Clinical decision support (CDSS) development**
- **CDSS maintenance**
- **Use of clinical heuristics**
- **Challenges of managing national drug formulary CDSS**

Pre-operative Evaluation in a Nutshell

- Established decisions on use of medications
  1. Indication and need
     I. Effect of stopping drug on primary disease
     II. Rebound effect
     III. Clinical deterioration
     IV. Withdrawal
  2. Drug pharmacokinetics & changes
  3. Absorption, half-life, ROA
  4. Potential adverse effects
     I. Bleeding, hypoglycemia, …
  5. Appropriate management of pain
  6. Administration of adjunctive medications
  7. Use of appropriate formulations and alternative products when needed
  8. Potential benefits of starting a drug prophylactically

- Hx
  - Chief problem
  - Surgery type
  - Type of anesthesia
- PMH (allergies, co-morbidities, injuries, …)
- Social Hx
  - Problems with bleeding, anesthesia, …
- Med. Recon.
- Physical exam
- Labs/tests
- Imaging reports
- A&P
  - surgery risks
  - effect of surgery on underlying disease(s)
  - PMM

Why Study PMM Informatics

- Medical decision making is difficult!
  - Substantial amount of knowledge required to solve even seemingly simple problems
  - Requires massive amounts of information recall and application
  - Cognitive ability becomes challenged
    - Multi-tasking
    - Limited reasoning
    - Memory capacity

Why Study PMM Informatics

- Decision making is particularly challenging in perioperative medicine:
  - Recall of information and processing of clinical data spanning multiple clinical specialties
  - Knowledge of medication-related issues
    - Particularly challenging with patients who take several medications!
  - Need to close decision making loop to communicate results with patients to manage care transitions

Why Study PMM Informatics

- Increasing Surgical Burden
  - Aging population with greater functional recovery expectations
- As many as 44% of patients undergoing surgery take medications prior to surgery[1]
- Half of the general surgical patients take medications unrelated to surgery[2]
- Increased RR (2.7 times) of post-operative complications in patients who take meds not related to surgery vs patients taking no meds[2]

1. Kluger MT et al. *Anaesthesia ;*46(6):456-9 (1991)
2. Kennedy JM et al. *Br J Clin Pharm.* 49, 353–362 (2000)

Why Study PMM Informatics

- Medication errors contribute to patient morbidity and mortality[1]
- Ineffective care transition processes lead to adverse events[2]
- Although a general consensus exists for perioperative management of some medications, consensus is lacking for others[4]
  - Perioperative medication management decisions are often empirical and inconsistent among clinicians

1. Spell NO. *Med Clin N Am.* Jun;85(5):117-28. (2001)
2. Medicare Payment Advisory Commission, Report to the Congress: Reforming the Delivery System, Washington, D.C.: MedPAC, June 2008
3. Kroenke K. *S Med J* 91:358-364, (1998)

Clinical Decision Support Systems

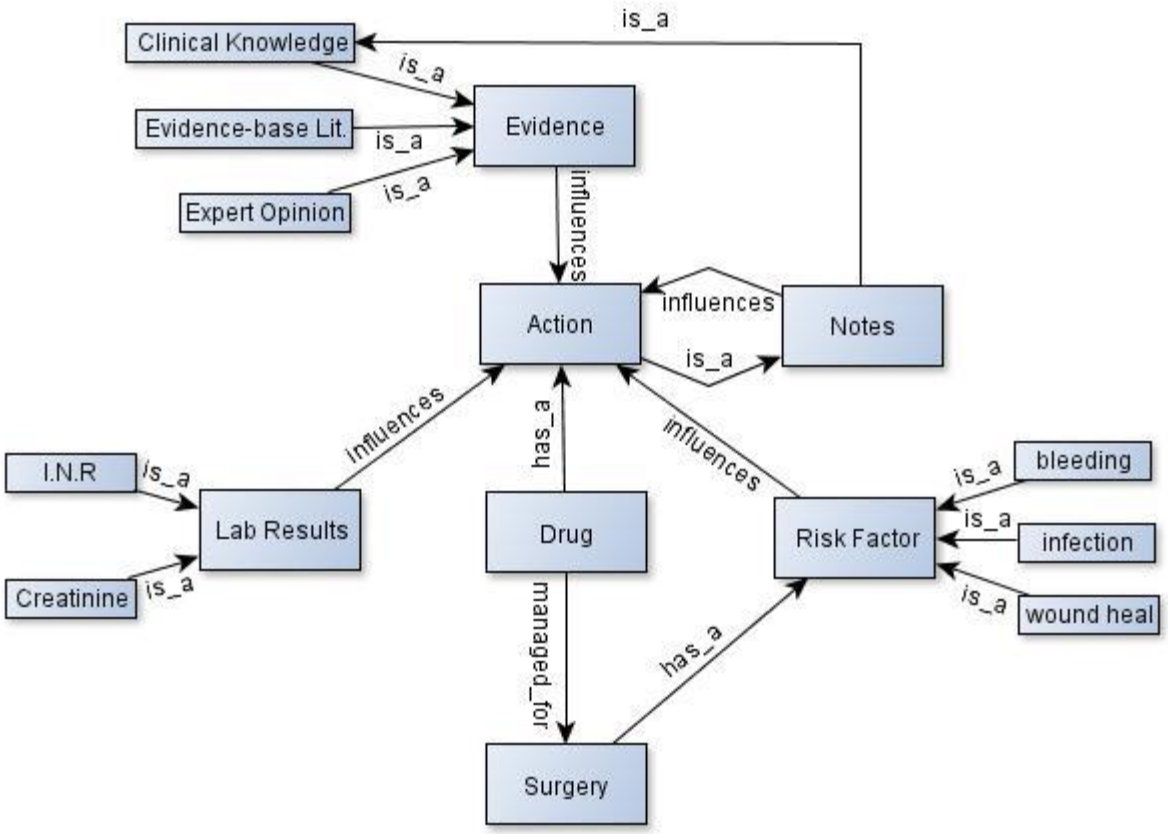
- Rule-Base (Expert System) CDSS
  - a special class of CDSS in which computer emulates the decision-making ability of a human expert.[1]
  - a "discipline that involves integrating knowledge into computer systems in order to solve complex problems
  - normally requires a high level of human expertise." [2]

1. Jackson P. *Introduction to Expert Systems*. 3 ed: Addison-Wesley, 1998.
2. Feigenbaum EA, et al. *The Fifth Generation*. 1 ed. Reading, MA: Addison-Wesley, 1983.

Knowledge Discovery and Management

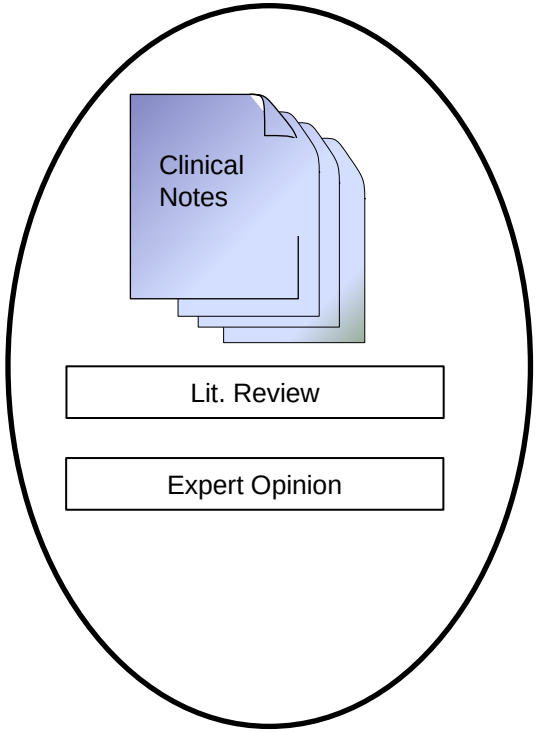
- Essential for developing a model to formally represent the PMM domain knowledge
- PMM ontology of concepts and relationships
  - Structural framework for use and organization of clinical information
  - Captures flow of information and data
  - Developed in consultation with two domain experts in internal medicine

PMM Ontology



Data Sources

- Clinical Notes
  - 100 randomly-selected pre-op notes between 8/1/2010 and 7/31/2012
  - Records originally created in *CPRS* EHR system
  - De-identified
  - Active outpatient meds and med. mgmt recommendations (actions)



Sample Note

Key:
Actionable drug
Action

Active Outpatient Medications

==========

1) GABAPENTIN 300MG …
2) GLIPIZIDE 10MG …
3) SIMVASTATIN 80MG …

--Medication recommendations

Give the following meds with a sip of water AM of surgery:
gabapentin

Start holding glipizide the evening pre-op.

Drug Classes & Categories

- Class source: VA's National Drug File (NDF), 6/2012 version
- Categories source: VA's Class Index File, 7/2012

1	TRADE	VA_PRODUCT	VA_CLASS
16423	COUMADIN	WARFARIN NA 2.5MG TAB	BL110
16424	PANWARFIN	WARFARIN NA 2.5MG TAB	BL110
16425	COUMADIN	WARFARIN NA 2.5MG TAB	BL110

BL110=Anticoagulants

Heuristics Development

- Create PMM recommendations development dataset manually:
  - Age
  - Gender
  - Surgery type & risks
    - Bleeding (tooth extraction vs limb amputation)
    - Infection
    - Wound Heal
  - Active Meds
  - Creatinine
  - INR
  - Classes
  - Actions (recommendations/decision heuristics)

Decision Heuristics (rules)

- Three domain experts (General Internists)
- One round of review
  - manual inspection of all drugs and actions in dataset
- Decision Criteria
  - Whether a drug is actionable, non-actionable, or unknown
  - Whether the action on a drug is the correct action
- Discrepancies noted and adjudicated

Supported Decisions

- Decision in EHR matched decision by reviewers
- ≥ 80% of the time

OR

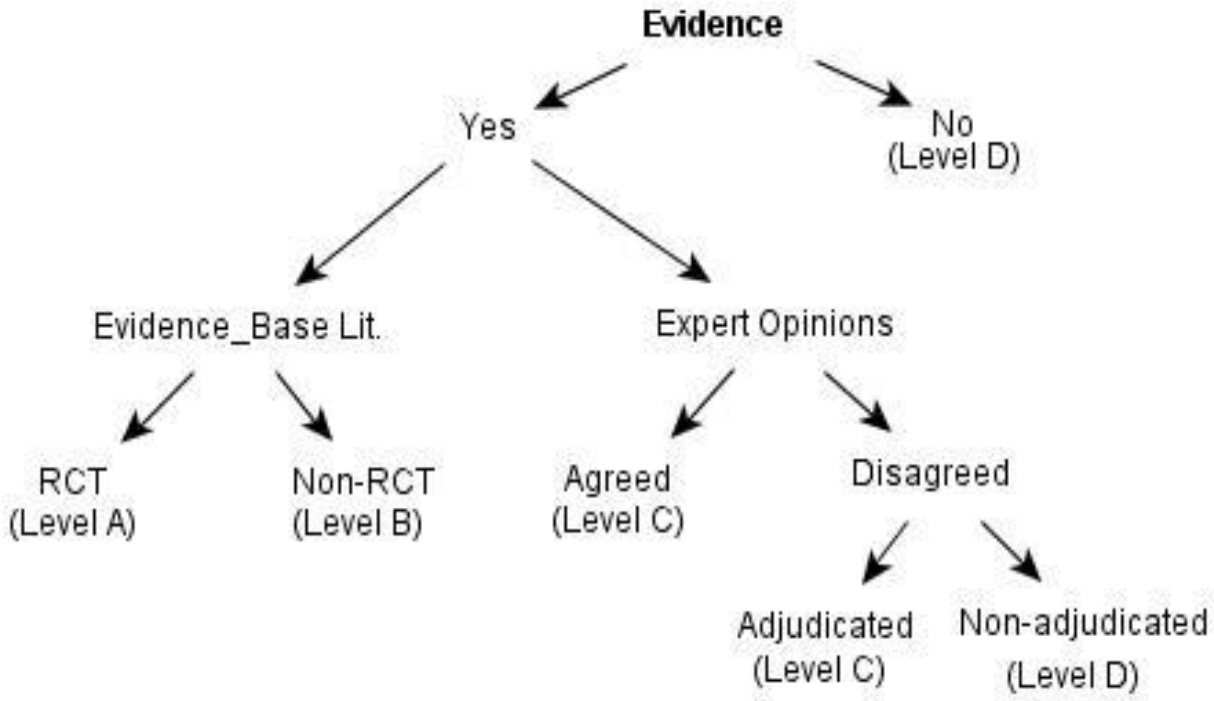
- If < 80% agreement, decision adjudicated by a 4th domain expert referee

OR

- Supporting evidence from E.B. literature

Tiered Supporting Evidence

- drug action heuristics for the entire VA drug formulary based on a tiered supporting evidence structure



Category-Level Recommendations


```
<drugclass>
<id>AN300</id>
   <instructions>No action recommended</instructions>
   <exception>
        <drug>
                <name>METHOTREXATE NA 2.5MG TAB</name>
                        <instructions>Safe to continue if normal
   creatinine level,otherwise hold 7-14 days prior:&lt;a
   href=&quot;http://www.ncbi.nlm.nih.gov/pubmed/?term=11171680+172043
   10&quot;target=_newpage;&gt; SUPPORTING EVIDENCE
   &lt;/a&gt;&lt;p;&gt;If minor surgery, safe to continue: &lt;a
   href=&quot;http://www.ncbi.nlm.nih.gov/pubmed/?term=20033813&quot;t
   arget=_newpage;&gt; SUPPORTING EVIDENCE &lt;/a&gt;&lt;/p;&gt;
   Evidence Level: B
                        </instructions>
        </drug>
   </exception>
</drugclass>
```

drug class (AN300=ANTINEOPLASTICS, ANTIMETABOLITES)

default recommendation

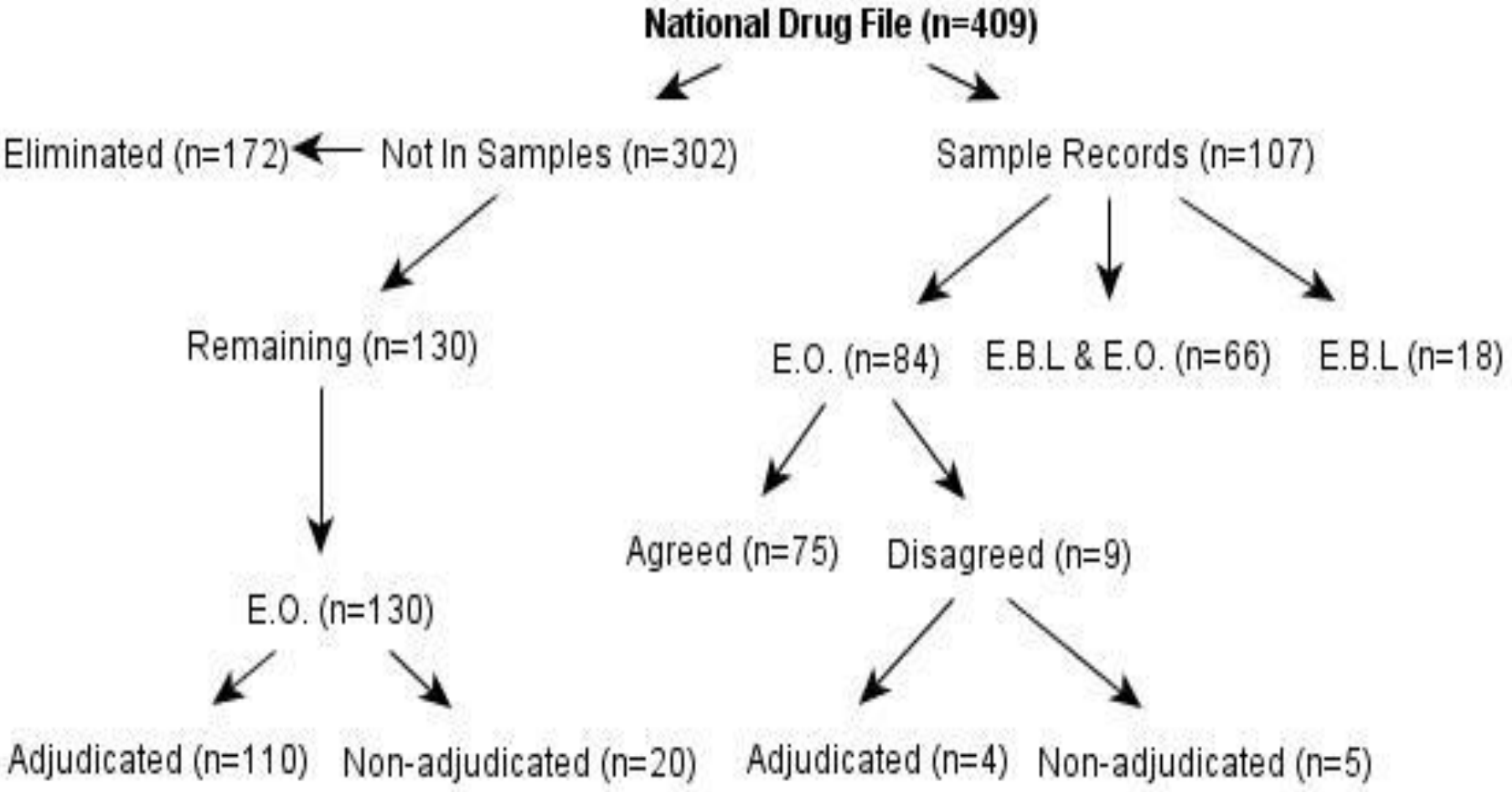
exception drug member

exception recommendation

supporting evidence

Results

Sources of supporting evidence (category-level)



Results

- 1,065 rules
  - 237 category-level rules covering ~10,000 drugs
    - Formulary for largest healthcare delivery system in the US
  - 828 exception rules

- Tiered levels of supporting evidence: 1,830
  - Level A: 184 (RCT)
  - Level B: 1,358 (Non-RCT)
  - Level C: 285 (Expert opinions)
  - Level D: 25 (Non-adjudicated expert opinions)

Decision Support Tool (PeriMed)

- Use the "rules" file developed in Study 1 as the inference engine to build the CDSS
- Test the accuracy of the CDSS against 100 (different) patient records in VistA/CPRS
  - Patients seen by our domain experts in Study 1 will be excluded (want the utility's decisions to be bias-free)
- Compare utility's output (actions) with domain expert opinions and measure % of recommendation matches

PeriMed Design & Development

- Web-based
  - Javascript
  - HTML
  - Python (2.7)
- Platform-independent
- Vendor-independent

Results

PeriMed's performance on "clinically significant drugs"[1]

First-round testing: match frequency =76%

1. Misinterpretations identified; rules adjusted
2. Outright differences noted; adjudicator agreed with tool in 69% of cases

Second-round testing: match frequency =96%*

* Compares favorably with like CDSSs

1. Cohn SL, et al. *Perioperative Medicine : just the facts*: 2006

Tool Demonstration

Discussion

- Sample size (n=100) was adequate for empirically building a patient-based CDSS
  - 92% of clinically-significant medications represented in the sample
- Validation of the proof of concept can be expanded for patient use
  - Prospective identification of at-risk patients
  - Follow-up assessment after preoperative evaluation to insure appropriate use of medications
  - Potential for use in integrated screening work

Discussion

- PeriMed possesses 3 key features associated with CDSS success[1]:
  - electronic rather than paper-based templates
  - provides decision support at the time and location of care rather than prior to or after the patient encounter
  - provides recommendations for care, not just assessments

Kawamoto K, et al. *B Med J* 2005;330(7494):765.

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Thank You!

- Questions?